OBITUARY NOTICES OF FELLOWS DECEASED.

THOMAS JEFFERY PARKER, eldest son of the late William Kitchen Parker, F.R.S., was born at 124, Tachbrook Street, London, S.W., on October 17, 1850. As a boy he showed a taste for literature and art rather than for science, and this taste was retained throughout life. Being brought up in London, he had little opportunity of developing a taste for outdoor natural history; indeed, in many letters to his friends Parker afterwards referred to this with regret. His subsequent work, and the introduction to the 'Text-Book of Zoology,' written in conjunction with his friend, Professor W. A. Haswell, F.R.S., and completed but a short time before his death, alike prove that his love of Nature was real and that he was fully alive to the importance of a knowledge of the appearance and habits of living things—as a preliminary to the more serious and academic study of the phenomena manifested by them.

Parker received his school training at Clarendon House, Kennington Road, living at home the while, and constitutionally he was never very robust nor much inclined for athletics. On leaving school he entered as a student at the Royal College of Chemistry and Royal School of Mines, where in 1871 he was awarded the Edward Forbes medal and prize of books for biology; and it was the contact with Huxley thus obtained, aided by the influence and loving example of his own father, which moulded Parker's after life. At that time the lectures given in the Royal School of Mines were illustrated only by specimens in the Museum of Practical Geology. Practical work was otherwise *nil* and of Huxley's discourses Parker wrote, "As one listened to him one felt that Comparative Anatomy was indeed worthy of the devotion of a life, and that to solve a morphological problem was as fine a thing as to win a battle." Thus inspired, Parker left Jermyn Street, to fill the office of science master at a school in Yorkshire; but in 1872 he returned to London, on the occasion of the transfer of the Department of Biology of the Royal School of Mines to the building now known as the Royal College of Science, at South Kensington, and shortly afterwards undertook, at Huxley's special request, the Demonstratorship in that subject—an event which marked the turning-point in his career. Writing of the work some years later, he remarked that, "With the exception of a fortnight's Science Teachers' Course and

a little instruction from Martin and Bridge, I had to pick up everything as I went on. I feel often quite aghast to think of my utter ignorance of the whole business when I began to demonstrate for Huxley; fully nine-tenths of the things I had never seen until I got into the laboratory, and how the students, to say nothing of the 'General,' stood it ('General' being a term by which Huxley was usually known in the college) is a mystery to me." The working-out of Huxley's splendidly conceived plan of practical teaching of Biology was left largely in Parker's hands, and he was thereby afforded every opportunity for developing his powers both as a teacher and an organiser. Most successfully did he fulfil the task, and in the course of the eight years which he devoted to its development there came under his influence many persons now occupying prominent positions in the biological world, to whom his memory will be ever dear as that of a trusty guide and a true friend. Parker's demonstrations were well worthy the lectures of his great chief; and in the intervals between the courses of instruction he gradually organised a teaching collection, and made, in more direct connection with the work of the laboratory, a number of exquisite dissections with accompanying drawings of representative animal forms. In this it was the good fortune of the present writer to assist, and copies of the drawings, now on the walls of the Biological Laboratory at South Kensington, were in course of time furnished to many of the universities and colleges in the United Kingdom, America, and on the continent of Europe. In this way Parker will ever be remembered as the foremost agent in the development of the Huxleyan method of laboratory instruction; and while it was to him that the more significant modifications undergone by this method up to the time of his leaving England were due, it is interesting to note that of all those who were prominently concerned in its inception, he alone continued to teach both Botany and Zoology to the end of his career.

Early imbued with a desire to emulate his great chief, Parker, in the intervals of official work, commenced writing, and amongst the more popular articles which emanated from his pen may be mentioned the biological portions of the "Recent Science," in the early numbers of the 'Nineteenth Century,' and the article "Carnivora" in 'Cassell's Natural History' (which he wrote in conjunction with his father), together with critical reviews, contributed to the pages of contemporary scientific journals.

Parker's original researches during the period of his service under Huxley were undertaken on his own initiative, the great master being far too engrossed in his own special occupations, and abstracted by polemical and other responsibilities imposed by an eager multitude, to be able to take much personal interest in those working under him. The earlier among Parker's scientific papers, viz., those dealing

with the "Stomach of the Fresh-water Crayfish,"* and the "Stridulating Organ of Palinurus"† bear nevertheless a direct relationship to the work of Huxley's class room. These were followed by others on the "Histology of *Hydra fusca*,"‡ on the "Intestinal Spiral Valve in the genus Raia,"§ and on "Some Applications of Osmic Acid to Microscopic Purposes."‖ In publishing the latter, Parker established for himself a reputation as one of the first to apply the then prevailing zoologists' methods to the preparation of microscopic sections of plant tissues, and he will further be memorably associated with the progress of vegetable histology as having been the first to discover and briefly describe the existence of sieve-tubes in the marine alga *Macrocystis*.¶

While in London Parker became Lecturer on Biology at Bedford College and an Assistant Editor of the 'Journal of the Royal Microscopical Society,' and he served as Examiner in Zoology and Botany at the University of Aberdeen and as an Assistant Examiner in Physiology to the Science and Art Department.

In 1880 he was appointed Professor of Biology in the University of Otago, Dunedin, New Zealand, which office he filled with great credit to himself until the day of his death. Soon after his arrival at the Antipodes, he described** a new Holothurian (*Chirodota dunedinensis*), in promise, as it were, of the magnificent faunistic work since performed by some of those who afterwards became his colleagues in the task of Australian and Novo-Zelandian exploration, and of which we could have wished that Parker had given us more. His mind centred in morphological inquiry, which he continued in full earnest. Among his forty odd published monographs those dealing with the "Anatomy and Development of Apteryx"†† and the "Cranial Osteology, Classification, and Phylogeny of the Dinornithidæ'‡‡ will always be prominent among biological achievements at the Antipodes; but there remain others, such as his later monograph on the "Structure of the Head in Palinurus"§§ and that on the "Myology of the species *P. Edwardsii* (published in the Macleay Memorial Volume, in conjunction with a lady pupil), which link together his work at home and in New Zealand in an interesting association revealing continuity of ideas.

As a teacher, writer, and lecturer Parker was always clear. Unlike

* 'Journ. Anat. and Phys.,' vol. 11.
† 'Zool. Soc. Proc.,' 1878.
‡ 'Roy. Soc. Proc.,' vol. 30, and 'Quart. Journ. Micr. Sci.,' vol. 20.
§ 'Zool. Soc. Trans.,' vol. 11.
‖ 'Roy. Micr. Soc. Journ.,' vol. 2.
¶ 'N. Z. Inst. Trans.,' vol. 14.
** 'N. Z. Inst. Trans.,' vol. 13.
†† 'Phil. Trans.,' 1892.
‡‡ 'Zool. Soc. Trans.,' vol. 13.
§§ 'N. Z. Inst. Trans.,' vol. 16.

his father, who "was a seer but not an expositor," he was logical in his methods, and was careful to present his facts and arguments in fitting sequence.

In literary style Parker seemed to have been largely influenced by Huxley, Matthew Arnold, and Russell Lowell, many of the writings of each of whom he knew almost by heart, and the reports of some of his popular addresses do credit to his choice. This may be truly said of a speech made by him on the occasion of the distribution of prizes at the Otago Boys' High School, on December 13, 1894, which was enlivened by a witty vein of rare merit, and showed Parker to have been possessed of a keen sense of humour. Soon after his arrival in Otago he delivered his "Inaugural Address," taking as his subject 'Biology as an Academic Study.' In this he ventured to insist on the importance of Darwin's work. But at that time the doctrine of evolution was apparently looked upon by the inhabitants of Dunedin as a bad form of heresy, and the address, as well as a lecture he gave some two years later, on Darwin, produced a storm in the local newspapers. Parker, however, prevailed, and his subsequent addresses and lectures on biological and educational subjects show him to have been intent on progressive measures. Pursuing these with a literary facility, quiet humour, and with common-sense views on general educational questions, we find him extending his influence beyond the limitations of his own department in his University, and becoming largely responsible for the introduction of many improvements in the Degree Regulations which have been to the advantage of all concerned. He was a strong advocate of higher educational aims, and lost no opportunity of insisting on the importance of post-graduate study. With this in view, he instigated several of his students to undertake research, and established in connection with their work a series of 'Studies in Biology for New Zealand Students,' the chief among which appeared as contributions to the publications of the Museum and Geological Survey Department of that Colony.

The duties of Professor of Biology at Dunedin include the Curatorship of the large and important museum of the University, and in this work Parker showed an exceptional talent. In addition to arranging the collections already there, he from time to time added to them, and greatly developed them along modern and improved lines. Before leaving England he had been led to experiment on methods of preservation, it being a desire of his artistic nature to ensure if possible the retention of their natural colours by museum-preserved animals. In this he did not succeed, but in seeking to conserve cartilaginous skeletons so that they might be examined high and dry, he achieved a notable result by the employment of a glycerine jelly method. Conspicuous among his labours in this direction skeletons of *Carcharodon*, *Callorhynchus*, *Notidanus*, and *Torpedo*, together with numerous lesser

preparations, may be seen in the British Museum of Natural History, the Cambridge University Museum, and elsewhere at home and at the Antipodes, which have stood the test of prolonged display and exposure to the action of light and air. Mainly in association with his curatorial work, there appeared from time to time in the pages of 'Nature' a series of "Notes from the Otago Museum," which, while serving as a record of his manipulative experience, embody important observations and discoveries, and have proved of great service to *préparateurs*.

As a writer of books, Parker was no less successful than in his other vocations, and in a charming biographical sketch of his father, written in 1893, he realised a high literary standard. His first published volume, a 'Course of Instruction in Zootomy (Vertebrata),' appeared in 1884, three years after his settlement in New Zealand. It was, however, for the greater part prepared before he left England, and with the exception of Huxley and Martin's 'Elementary Biology,' in the final revision of the proofs of which Parker had a hand, it was the first in the field among laboratory treatises of the now familiar didactic order. During the preparation of the earlier part of this highly successful work, Parker materially assisted Huxley with the anatomical portion of the latter's ideal book upon 'The Crayfish,' at that time in course of preparation. It is doubtful if there has ever appeared a more perfect treatise upon any one single organic being than this; and Parker, through it and his earlier published papers conspicuously associated with Huxley's epoch-marking labours in scientific education, seemed under the hand of fate concerning the Crayfish and its allies; for in his 'Skeleton of the New Zealand Crayfishes,' which appeared in 1889, he developed most conspicuously his own ideas of laboratory organisation. Parker's powers of exposition of his subject may best be judged by his 'Lessons in Elementary Biology' (1891). The scheme for this book was already in his mind while demonstrating under Huxley, and the work itself, at present in its third edition, has been translated into German, and now occupies the foremost position among all elementary treatises of biology not intended for laboratory use.

Parker's affectionate nature and charm of personal manner endeared him to wide circle of friends, and amongst his students he was a general favourite. His unassuming character, and his literary, artistic, and musical tastes, resulted in a wide sympathy with all sorts and conditions of men. He took an active part in the social life of Dunedin and was President of the Savage Club, as well as of the Otago branch of the New Zealand Institute. He was elected a Fellow of the Royal Society in 1888, and in 1892 was granted the degree of D.Sc. *in absentia* by the University of London. He was a Corresponding Member of the Zoological Society of London and of the Linnean Society of New South Wales, an Associate of the Linnean Society of London, of which he became a Fellow at about the time of his

death, and he was a Member of the Imperial Society of Naturalists of Moscow. The gradual decline of his wife's health did much to sadden many years of Parker's life, and some little time after her death, as well as that of his father and mother, symptoms of an organic ailment became apparent, to which he eventually succumbed. But he had learned to bear his burden quietly and with manliness, and in spite of trouble sufficient to crush many a stronger person, he showed a cheerful face to the world, and found happiness in his work and home-life. In the autumn of 1892 he came on a visit to England, intending to visit the European Museums for the examination of remains of the Dinornithidæ, in order to complete his monograph on that group. At the end of the time he had the great delight of spending a few days at Eastbourne with his old chief, of his admiration for whom he afterwards wrote :—"Whether a professor is usually a hero to his demonstrator I cannot say; I only know that, looking back across an interval of many years and a distance of half the circumference of the globe, I have never ceased to be impressed with the manliness and sincerity of his character, his complete honesty of purpose, his high moral standard, his scorn of everything mean or shifty, his firm determination to speak what he held to be truth at whatever cost of popularity. And for these things I loved the man, and do honour to his memory, on this side idolatry, as much as any."

Parker's last completed piece of work was his aforementioned 'Text-Book of Zoology,' written in conjunction with Professor W. A. Haswell, F.R.S., of the Sydney University. This was begun in 1892, and though all the proofs were corrected before his death, he did not live to see it published. The original plan of this beautifully illustrated book, the clearness of the well-balanced descriptions, as well as of the parts dealing with the wider and more general aspects of the subject, place it in the front rank of elementary zoological text-books; and throughout the work it is evident that the authors have been more careful to supply what is best for the beginner than to impress the reader with their own wide acquaintance with details. A shorter form of this book was in course of preparation at the time of Parker's death, and he had nearly completed half the manuscript for a 'Biology for Beginners,' and was making plans with his brother, Professor W. N. Parker, for the preparation of an 'Elementary Practical Zoology.' He had also begun, in conjunction with Mr. J. P. Hill, of Sydney University, an investigation on some Emeu chicks, and had obtained interesting results.

In the autumn of 1895, Parker suffered from a bad attack of influenza, and the following year he paid a visit to Sydney; but the journey was apparently beyond his strength. A second attack of influenza in the summer of 1897 completely prostrated him, and was followed by serious symptoms. Again and again he tried to resume

work, but each attempt resulted in a relapse, and at the close of the academic session, towards the end of October, it was thought best for him to try the effects of a complete change. Accompanied by his sister, who had joined him and his three boys in Dunedin shortly after the death of his wife, he started on a visit to his friend, Mr. Bell, of Shag Valley, about forty miles from Dunedin. But halfway there he was so prostrated that the continuation of the journey had to be postponed, and a week later it was decided to return to Dunedin by easy stages. After a night's rest at Warrington, he seemed to be better, but the same night he began gradually to sink, and died a few days later—on November 7, 1897. He was buried at Warrington, and a number of his Dunedin friends accompanied him to the grave. His unexpected death, at the age of 47, is a severe loss to biological science in the Antipodes, where he was one of its foremost pioneers.

G. B. H.

PERCIVAL FROST was born at Kingston-upon-Hull on September 1, 1817. He was the second son of Mr. Charles Frost, F.S.A., who practised as a solicitor in that town. Percival Frost's earlier school-life was spent at Beverley. From Beverley he was removed in the year 1833 to Oakham School, which was then presided over by Dr. Doncaster, and here he remained until October, 1835, when he proceeded to St. John's College, Cambridge.

As an undergraduate, Frost devoted most of his energies to the study of mathematics. The competition which Frost met with at St. John's College is sufficiently apparent from the fact that in his year, 1839, the first four places in the Mathematical Tripos were won by men of his own college; a unique example of one college obtaining the first four places in that Tripos. Frost's chief rival was B. M. Cowie, the present Dean of Exeter. In the Mathematical Tripos, in January, 1839, Cowie was Senior Wrangler, and Frost was Second Wrangler; but immediately afterwards this order was reversed by the examiners for the Smith's Prizes. Both were elected to fellowships in their College on the same day, 18th March, 1839.

After his degree, Frost was urged by friends, and especially by Dr. Hymers, his college tutor, to read for the Bar, and he commenced to do so; but his great success in obtaining private pupils when he returned to Cambridge for the Long Vacation, induced him to abandon all idea of the legal profession. In 1841 Frost was ordained by the Bishop of Ely, and in the same year vacated his fellowship on his marriage with Jennett Louise, daughter of Mr. Dixon, of Oak Lodge, Finchley, the commencement of a happy union which lasted 57 years. Frost held a mathematical lectureship in Jesus College from 1847 to 1859, and one in King's College from 1859 to 1889; but his chief work consisted in the tuition of private pupils.

In this work he was eminently successful; many of his pupils took high degrees. As examples of those who rose to distinction at the Bar and in Science, may be mentioned the names of Lord Justice Rigby and the late W. K. Clifford.

The first book which Frost wrote was an edition of Newton's 'Principia,' Book I, sections 1—3 (with notes and illustrations, and a collection of Problems); it was published in 1854. Subsequent editions appeared in 1863, 1878, and 1883. His next work he published in 1863, in conjunction with the late Joseph Wolstenholme. It was entitled 'A Treatise on Solid Geometry.' Second and third editions of this work were published by Frost alone in 1875 and 1886, and 'Hints for Solution of Problems in the Third Edition of Solid Geometry,' in 1887. In 1872 he published his third work, 'A Treatise on Curve-tracing.' In addition to these books, he wrote a considerable number of minor papers relating to Algebra, Analytical Geometry, the Lunar and Planetary Theories, and Electricity and Magnetism, more than twenty of which appear in this Society's 'Catalogue of Scientific Papers.'

In 1882 Frost was elected a Fellow of the Royal Society, and in the same year he was elected by King's College, Cambridge, to a terminable Fellowship, to which he was re-elected three times, and which he held at the time of his death. By new University Statutes, which came into force in 1882, two new degrees were established at Cambridge, those of Doctor of Science and Doctor of Letters. Shortly afterwards, Frost proceeded to the degree of Sc.D.

Frost was no mere mathematician; he was a man of wide interests and varied attainments. He had an extensive acquaintance with the works of musical composers, and his execution on the pianoforte was of a high order. His drawings in water colours were very successful. Moreover, he had a Yorkshireman's instinctive love for games and sports.

Frost possessed a strong constitution, and enjoyed excellent health. If we make an exception of the lameness of his later years, against which he courageously fought, he scarcely knew, until he had passed his 80th birthday, what a day's illness was. Towards the end of last April, he was attacked by a painful disorder, which in six weeks' time proved fatal to a frame exhausted by prolonged suffering. Frost died on Trinity Sunday, June 5, 1898, and his remains were laid to rest on the following Friday in the Mill Road Cemetery, Cambridge.

Frost's character endeared him to all who knew him. He was admired and esteemed by his pupils; and between him and them many a life-long friendship was established. His kindness of heart and consideration for others could not be exceeded. If there was anything that he abhorred, it was what seemed to be self-conceit and pretentiousness. He was always bright and cheerful, and ready to see fun in any situation which might occur.

The writer of these lines takes this opportunity of recording his own deep debt of gratitude to Dr. Frost. Some four years ago, when the writer ceased to be able to read, Dr. Frost with characteristic kindness and generosity volunteered to act as reader. His readings, which took place three or four times a week, and lasted about an hour and a half each, were continued until Dr. Frost was attacked by his fatal illness. In that period something like thirty octavo volumes, on subjects of diverse interest, were read, as well as a sprinkling of special articles from the 'Times,' or papers in 'Nature' and other scientific periodicals.

The memory of such a friend cannot easily fade.

H. M. T.

LYON PLAYFAIR, son of Dr. George Playfair, Chief Inspector General of Hospitals, Bengal, was born at Meerut, May 21, 1819. He came home for his education to St. Andrews, where his grandfather had been Principal of the United College of St. Salvator and St. Leonard, and where his uncle, Sir Hugh Lyon Playfair, after a distinguished career in the Indian army, retired in 1834, not to repose but to new battles against dirt, disorder, and ruin, battles the result of which we see in the clean, prosperous, and healthy city of St. Andrews. We may well believe that Lord Playfair derived some of his enthusiasm for sanitation and order from this uncle, "the eccentric and energetic soldier who begged and bullied and wheedled away the filth and ruinous neglect which bade fair to entomb the ancient city." After some years in St. Andrews, he went to Glasgow to study medicine, but was attracted to chemistry by the teaching of Thomas Graham, then Professor of Chemistry in the Andersonian. After a short visit to India he resumed his chemical studies, under Graham, in the University College, London. In 1838 he went to Liebig's laboratory at Giessen, where he worked at organic chemistry and produced his first scientific paper "On a new Fat Acid in the Butter of Nutmegs." Liebig was not only his teacher but his friend, and when Liebig, on the invitation of Prince Albert, came to this country to lecture on agricultural chemistry, Playfair acted as his assistant and interpreter, and was thus introduced to the Prince, an introduction which had an important effect on his subsequent life.

For two years he managed the chemical department of Messrs. Thomson's print-works, at Clitheroe. In 1843 he was appointed Professor of Chemistry in the Royal Institution, Manchester. In 1844, on the recommendation of Sir Robert Peel, he was appointed a member of a Royal Commission for the examination of the sanitary condition of large towns and populous districts. This was the beginning of what was to be a large part of the work of his life. In 1845 he was one of the commissioners on the Irish famine, and from that time till his death

there was no year during which he was not appointed to serve on a Royal Commission or a Select Committee of the House of Commons, in very many cases as chairman. Among the Commissions on which he served, besides those already named, may be mentioned—Exhibition of 1851, Exhibition of 1862, the Cattle Plague, the Reorganisation of the Civil Service (the report of which is still known officially as "The Playfair Scheme"), Pensions for the Aged Poor, the University of London, the Herring Fisheries of the United Kingdom, Coal for the Navy.

In 1846 he was appointed chemist to the Museum of Practical Geology and Professor of Chemistry in the Government School of Mines.

As Special Commissioner in charge of the Department of Juries at the great Exhibition of 1851, Playfair had an entirely new task before him. This was the first International Exhibition, he had no precedent to work upon, what he did was quite original, and it was so well done that it became the model for all succeeding international exhibitions. There can be no doubt that the success of the 1851 Exhibition was to a great extent due to Playfair's clear view of what ought to be done and of what could be done, and to his untiring energy in doing it and in getting other people to do it. The value of this work was recognised in the highest quarters and Playfair became a Companion of the Bath, and an officer in the household of the Prince Consort. A more striking proof of the value set by others on his services was the fact that he was asked to undertake the same duty in connection with the Exhibition of 1862, as also that at the Paris Exhibition in 1878, the Prince of Wales, who was President of the British Commission, appointed him chairman of the Finance Committee.

The 1851 Exhibition led in 1853 to the foundation of the Department of Science and Art, and Playfair and the late Sir Henry Cole were appointed joint secretaries. In 1856 Playfair became Inspector-General of Government Museums and Schools of Science. These offices he held till 1858, when on the death of Professor Gregory he was appointed to the chair of Chemistry in the University of Edinburgh. In Edinburgh he created, practically out of nothing, a really useful teaching laboratory. The rooms then available were very ill-suited for the purpose and the funds quite inadequate, but he made the most of the former and supplemented the latter, spending on the department the whole of his professorial income during the first year and a large part of it for several subsequent years of his tenure of office. The University of Edinburgh is also indebted to Playfair for the introduction of degrees in science. In 1868 Playfair was returned as the first representative in Parliament of the Universities of St. Andrews and Edinburgh. He was Postmaster-General in 1873, and Chairman of Ways and Means and Deputy-Speaker from 1880 to 1883. On his retirement from this office he was made K.C.B. At the general

election in 1885 he was returned for the Southern Division of Leeds and was appointed Vice-President of the Council on Education. He continued to represent Leeds until he was raised to the Peerage in 1892.

Playfair was an original member of the Chemical Society of London, over which he presided in 1857—1859. He was elected a Fellow of this Society in 1848, and of the Royal Society of Edinburgh in 1859. He was President of the Chemical Section of the British Association in 1855 and in 1859, and of the Association in 1885. He was an honorary member of many foreign learned bodies and held many foreign decorations. He died in London, on Sunday, May 29, 1898.

Playfair had a truly scientific mind and was always busy, and yet we do not find a great deal of original scientific work recorded under his name in the 'Royal Society Catalogue of Scientific Papers.' His work lay mostly in another direction. As he belonged not only to the world of science but also to that of practical business, he was specially fitted to act as an interpreter between them. Such an interpreter is needed. The man of science does not always know what the business man wants, and the business man often does not understand what the man of science tells him. Such services are perhaps appreciated more highly by the man who immediately feels the benefit of them, the statesman, the manufacturer or the merchant, than by the man of science, but we should remember that if science takes a higher place now than it took fifty years ago, if the opportunities for the genuine study of science and for the prosecution of scientific investigation are greater now than they were then, if science is taking more nearly its right place in the education of the country, that is due to a large extent to Playfair's wisdom and hard work. Of Playfair's contributions to pure chemistry the most important is the discovery and investigation of the nitroprussides, and to applied chemistry, the report on the work undertaken by him along with Bunsen on the gases evolved in iron furnaces. But besides what was published in scientific journals, or in the Transactions of learned societies, Playfair did a great deal of original scientific work, how much no one can now tell, incidentally in the course of the investigations of the numerous commissions of which he was a member.

A. C. B.

Brigade-Surgeon JAMES EDWARD TIERNEY AITCHISON, M.D., C.I.E., F.R.S., F.L.S., LL.D.,* died at Kew, on September 30, 1898, after a considerable period of suffering from a weak heart and other diseases. He was a son of the late Major James Aitchison, and was born at

* Much of this notice is word for word the same as one I drew up for 'Nature' and the 'Kew Bulletin.'—W. B. H.

Neemuch, Central India, on October 28, 1835. His education was begun at the parish school of Lasswade, Midlothian; thence he went to the Grammar School at Dalkeith, and subsequently to the Academy and University of Edinburgh. After graduating M.D. and L.R.C.P. in 1856, he entered the service of the Honourable East India Company, as Assistant-Surgeon, in 1858, and retired in 1888. We have no particulars of his early life, but he seems to have taken up botany soon after his arrival in India, for in 1863 he published an account of the 'Flora of the Jhelum District of the Punjab.' This was followed by a 'Catalogue of the Plants of the Punjab and Sindh,' in 1869, and other papers on economic and geographical botany. He had already long been in communication with Kew, where his first collection of dried plants, comprising between 300 and 400 species, was received in 1862. These plants were from the districts named in the foregoing titles, and included little that was actually new to science; but the specimens were so carefully selected and so well dried that they were valuable on that account. In 1872 he was appointed British Commissioner to Ladak, where he continued collecting on a small scale, and transmitted his plants to Kew.

Dr. Aitchison's more active career in scientific pursuits began, however, when he accompanied the troops under General (now Lord) Roberts into the Kuram Valley, Afghanistan, in 1878, when he served with the 29th Punjab Regiment, Native Infantry. The following year he was attached to the force as botanist, and during 1879 and 1880 he very thoroughly explored the country from Thal to the Shutar Gardan, at elevations ranging from 2,000 feet up to 13,000 feet, on Mount Seratigah, and 15,000 feet on Mount Sikaram. The collection of dried plants of 1879 consisted of 950 species, represented by 10,000 specimens, and was published in the eighteenth volume of the 'Journal of the Linnean Society.' Nearly as large a collection was made in 1880, and this was published in the nineteenth volume of the same Journal. Subsequently, Dr. Aitchison was appointed Naturalist to the Afghan Delimitation Commission, and on that expedition, during 1884–85, he made his most important collections, both botanical and zoological.

The route was from Quetta through Northern Baluchistan, and thence northward, touching the Helmund, in about 63° longitude; up this river, onward into the valleys of the Harut and Hari Rud rivers, and thence to Meshed. Subsequently an excursion was made into Russian Turkestan, as far east as the Morgab river.

The country traversed is noted for its vegetable productions, especially drugs, many of uncertain origin, and although he made a general collection, Aitchison applied himself, successfully, to the investigation of their sources. His botanical collection on this journey comprised about 800 species, and 10,000 specimens. It is the subject of a memoir in the 'Transactions of the Linnean Society' (2nd series, Botany,

vol. 3), illustrated by fifty plates. The gum-yielding Umbelliferæ, of which he brought home a magnificent series of specimens, form a special feature of this memoir.

The zoological collection, though less comprehensive, included a considerable number of novelties; and was also published in the 'Transactions of the Linnean Society' (2nd series, Zoology, vol. 5), and illustrated by a number of plates. Each of the papers to which reference has been given, is preceded by an essay on the vegetation and vegetable products, both wild and cultivated, of the countries explored, and thus contains much valuable information. It ought to be added that these collections were made under very great difficulties, such as would have discomfited a man of less determination and endurance. He loved his beautiful specimens, and handled them as though they were the most delicate organisms. They are now incorporated in the herbaria of no fewer than sixteen different establishments.

Aitchison was of an enthusiastic and energetic temperament, and of an amiable and warm-hearted disposition, and many will feel the loss of so true a friend. Much of his success in collecting in a hostile country was due to his kindness to the natives, especially the sick, whom he treated medically or surgically. Such was his reputation, that it preceded him and ensured him a friendly reception.

For the Kuram campaign Dr. Aitchison received the medal and clasp; in 1882 he was elected a Fellow of the Royal Society of Edinburgh; in 1883 he was elected a Fellow of the Royal Society of London; and in the same year he was created a Companion of the Order of the Indian Empire. In 1892 he unsuccessfully contested the seat in Parliament for Clackmannan and Kinross in the Liberal Unionist interest. During the last years of his life he was engaged collecting materials for a 'Flora Indiæ Desertæ,' that is of North West India, Afghanistan, and Baluchistan; but his sufferings prevented him from working them out.

W. B. H.

Mr. Osbert Salvin, was born at Elmshurst, Finchley, on the 25th of February, 1835, being the second son of the late Mr. Anthony Salvin, the well-known architect, and Anne, daughter of the Rev. Wm. Nesfield, Rector of Brancepeth, in the county of Durham. Early in the year 1852, the front of Trinity Hall, in Cambridge, was destroyed by fire, and the professional services of Mr. Salvin were employed in rebuilding that part of the College. The result of this connexion between him and its authorities was, that in 1853, he placed his son, who (after a preparatory course at the Manor House, Finchley, kept by the Rev. Charles Worsley) had just left Westminster School, under their care, and the choice was justified by the latter obtaining a scholarship at the end of his first year. While at college, however, he was considered

not to do justice to his abilities; and, though he graduated as a Senior Optime in the Mathematical Tripos of 1857, it was thought that he could easily have secured for himself a much higher place. The truth is, that being a naturalist born—as a child his delight was in gathering wild plants, and bringing them to his elders to be named—he devoted far more time and attention to Natural History than to Mathematics, and diligently worked, so far as opportunity would allow, at Zoology and Geology—birds and insects being his favourite study in the former, and in the latter science the palæontological branch. Rowing was also another recreation, and he pulled the seventh oar in the boat sent by his college to Henley in 1856. Being singularly apt with his fingers, he found much occupation in carpentry and machinery—indeed, while at Westminster, he and his elder brother (his senior by a few years only) built and fitted two small steamers, which worked so efficiently that they were bought to be used on some of the rivers in India. With all these distracting tastes, it is not surprising that Osbert Salvin should have studied mathematics only enough to ensure his attaining a respectable degree,* and eventually the practical pursuit of zoology asserted itself almost to the exclusion of its rivals. Coming from Westminster he naturally had many friends among his old schoolfellows, who had joined the Third Trinity Boat Club, composed wholly of men from that school and Eton, and thus he came to know Mr. Frederick Godman (an Etonian), with whom he was subsequently to become so intimate a fellow-worker; while he also formed a close acquaintance with Mr. (afterwards Sir) Edward Newton, of Magdalene College, an enthusiastic ornithologist, through whose means Mr. Salvin was introduced to Mr. W. H. Hudleston (then Simpson). With this gentleman Mr. Salvin, immediately after taking his degree, set out to join Mr. (now Canon) Tristram, who was by marriage his second cousin, in the Natural History Exploration of Tunis and Eastern Algeria, where the party passed five months, throwing an abundance of light on the zoology of those countries, as the accounts published in 'The Ibis' for 1859 and 1860 shew. Soon after his return from this expedition, which will always be memorable in the annals of Ornithology, Mr. Salvin prepared to go to Central America, and in the autumn of 1857, proceeded to Guatemala, in company with the late Mr. George Ure Skinner, the celebrated discoverer and importer of Orchids, staying in that country till the middle of the following year, when on his way home he for a short time joined Mr. Edward Newton, then in the Antilles. A few months later, Mr. Salvin returned to Central America, henceforth always to be associated with his name, since there he proved himself to be unsurpassed as a collector, though those were the days of Bates and Wallace. Like those great naturalists, he used intelligence in his col-

* A place in the Natural Sciences Tripos of his day did not of itself admit to a degree, or he would probably have graduated in that way.

lecting, and the several papers that he published (far too few), telling of his experience in that country, bear abundant evidence of the reflective and trained mind of the observer, as well as his moral perseverance and physical endurance, in proof of which may be especially cited his articles in 'The Ibis,' on collecting *Trochilidæ* at Dueñas and other places, and on the habits of the Quezal or Resplendent Trogon (*Pharomaceous mocinno*) in Vera Paz. Returning to England in May, 1860, he again went out in the autumn of 1861, this time accompanied by Mr. Godman, continuing with greater success than before his former explorations, and ere the year was out had twice ascended the southern or fire peak of the Volcan de Fuego, near the city of Guatemala ('Athenæum,' No. 1793, March 8, 1862, p. 331). The collections made in this tour, which did not end till January, 1863, were very large, and comprised every class of the Fauna, while the Flora was not neglected, and many of the ruined temples and other remains of antiquity were visited and photographed. Soon after his return home, Mr. Salvin was induced to undertake the management of some engineering works in the north of England, but this employment, which he found very distasteful to him, did not last long. In 1865 he married Caroline, the daughter of Mr. W. W. Maitland, of Loughton, in Essex, and sister of an old friend and contemporary at Trinity Hall, Mr. John Whitaker Maitland, and, in 1873, set out with her on another voyage to Central America, returning by way of the United States, chiefly with the object of examining the collections in the Museums of Washington, Philadelphia, New York, and Boston. In 1874, on the foundation of the Strickland Curatorship of Ornithology in the University of Cambridge, he accepted that office, which he filled until 1882, when, his father having died in 1881, he succeeded to the small but beautiful property at Hawksfold, near Haslemere, whither he removed, making it his permanent residence, though there was scarcely a week some days of which he did not pass in London, for he and Mr. Godman had conceived the idea of bringing out a 'Biologia Centrali-Americana,' being a complete Natural History of all the countries lying between Mexico and the Isthmus of Panama. This gigantic task—by far the greatest work of the kind ever attempted—taxed all their united efforts as well as those of the many contributors they enlisted. The botanical part has been completed, but the zoological portion, and that by Mr. Maudslay on the antiquities, are still in progress. Before beginning this, Mr. Salvin had edited the third series of 'The Ibis,' of which he had been, in 1858, one of the founders, and had brought out a 'Catalogue of the Strickland Collection of Birds in the Cambridge Museum,' which was published at the University Press. His earliest contributions to scientific literature, while still an Undergraduate, were to 'The Zoologist' for 1856 (p. 5278) and 1857 (p. 5593), and shew the precise regard for accuracy which throughout his

life was one of his chief characteristics. He also joined Mr. Sclater, who had long been working on the birds of South and Central America, in the publication of 'Exotic Ornithology' (a series of plates and accompanying memoirs—limited however to forms of the New World) and of the 'Nomenclator Avium Neotropicalium' (1873). He further contributed the *Trochilidæ* and *Procellariidæ*—on which last group he became the acknowledged authority—to the British Museum 'Catalogue of Birds' (vols. xvi and xxv), and almost his latest labour was that of completing and arranging the late Lord Lilford's 'Coloured Figures of British Birds,' while this Society's 'Catalogue of Scientific Papers,' enumerates forty-seven published by Mr. Salvin alone, fifty-four by him and Mr. Sclater jointly, and twenty-three by him and Mr. Godman. His chief entomological work, for the most part executed in conjunction with the gentleman last named, and ostensibly limited to the *Rhopalocera*, is to be found in their grand undertaking; but there are probably few pages in that publication which do not bear silent witness to his careful supervision.

Mention has been made of his skill in carpentry, and this was not without a very useful result. For several years he, with his own hands, constructed the cabinets needed to hold his ever-increasing collections, and was thereby led to think out a scheme for overcoming what almost all collectors had hitherto found to be a serious hindrance —the inconvenience produced by having, when arranging a collection systematically, to interpose shallow among deep drawers, or the converse, owing to the different size of the specimens to be housed, and causing in many cases a great waste of space. He devised a system of cabinets in which the drawers, each being a multiple of the same unit, became practically interchangeable. His plan, simple enough in theory, involved several ingenious improvements and adaptations, such as a technical expert only could supply, before it was perfected. Having been adopted by some of his private friends, it was introduced into the Museum of Zoology at Cambridge, and afterwards, with a modification, whereby the chief advantage of the original idea was lost, into the Natural History portion of the British Museum. Its use has since been very generally copied; for its merits, when understood, are obvious.

Elected to this Society in 1873, Mr. Salvin was also a member of the Linnean, the Zoological and the Entomological Societies, on the Councils of all of which he frequently served; and it may be truly said that there were few naturalists whose opinion was more often sought, for his advice was generally sound. His figure was well known at the Athenæum Club, and last year he was elected an Honorary Fellow of his old College. He had suffered for several years from an affection of the heart, and was well aware of the precarious tenure of his life. He continued in his usual condition of health until a few

days before his death, which took place at his house at Hawksfold, on the 1st of June, 1898. He is greatly missed by a large circle of friends, to whom his kindly nature and unassuming manner, to say nothing of the breadth of his scientific views, had greatly endeared him.

A. N.

JOHN HOPKINSON was born on July 27, 1849, son of Alderman Hopkinson, of Manchester, and of a daughter of Mr. John Dewhurst, of Skipton. He was the eldest of a distinguished family of brothers. Alfred Hopkinson, Q.C., is now Principal of Owens College, Charles Hopkinson and Edward Hopkinson, are engineers, and Albert Hopkinson is a doctor of medicine.

After an early training at Lindow Grove School and Queenwood, John entered Owens College before he was 16 years of age. He showed marked taste and capacity for mathematics and physics, and at the age of 18 went on to Cambridge, entering Trinity College. His academic career was one of particular distinction. In 1871 he was Senior Wrangler and first Smith's Prizeman, having meantime taken the London degree of D.Sc., as well as a Whitworth Scholarship. He was elected to a fellowship at Trinity, but he went down from the University immediately after taking his degree to become an engineering pupil in the works of Messrs. Wren and Hopkinson, where his father was a partner. A very short time spent there sufficed to complete his preparation for professional work, for in 1872 he entered the service of Messrs. Chance Brothers and Company, glassmakers, of Birmingham, as their engineering manager. An important section of Messrs. Chance's work related to lighthouse illumination, and in this field Hopkinson's scientific genius at once found scope. He set himself to the improvement of dioptric lights and introduced the system of producing a group of flashes by the rotation of the apparatus, for the purpose of giving a wider variety to aid sailors in distinguishing between different lights. In 1874 he issued a pamphlet pointing out the advantages of group-flashing lights and showing a simple dioptric apparatus suited to produce them. He also pointed out how easily the group flash could be given with catoptric apparatus. The system has found extensive application. It was applied for the first time in 1875 to the catoptric floating light on the Royal Sovereign Shoals, near Beachy Head, and has since been applied to several lightships by the Trinity Corporation. The first land light on Hopkinson's system was made in 1875, for Tampico Lighthouse, in the Gulf of Mexico, and this was soon followed by many more. Later, when the question arose of adopting electricity in lighthouses, Hopkinson's work did much to overcome the difficulties which attended the use of the new illuminant, and several of the early electric lighthouses were equipped to his designs. Probably the designs of no lighthouse engineer have

been more varied, or more uniformly successful than his. Two of his more considerable works—the lights of Macquarie and Tino—are described in a paper which he read before the Institution of Civil Engineers, in 1886.

In 1878 he removed from Birmingham to London to practice as a consulting engineer. But his connection with Messrs. Chance was not broken, and he remained for many years their scientific adviser. Lighthouse design, however, was only one of several fields of work in which the influence of his originality was coming to be strongly felt.

At the time of Hopkinson's removal to London the dynamo electric machine had just ceased to be regarded as little more than a scientific curiosity. Its application to electric lighting had begun; the possibility of reversing its function and using it as a motor had been pointed out; but the conditions which should govern its design were very imperfectly understood, and the patterns of machine then manufactured were crude, clumsy, and wasteful. It is to Hopkinson more than to any other man that the modern dynamo owes its efficiency. His first published work on the subject is to be found in two papers on electric lighting, which were read and discussed before the Institution of Mechanical Engineers in 1879 and 1880. These papers describe experiments made by the author on a Siemens dynamo, to determine the relation of the electrical output to the power expended in driving the machine. The relation of current to potential was exhibited graphically in a form which has since been widely used by electrical engineers under the name of the "Characteristic curve." This pioneer work was followed by a series of magnetic researches which paved the way for a general theory of the magnetic circuit of the dynamo machine published by the brothers John and Edward Hopkinson in the 'Philosophical Transactions' for 1886. The principles then laid down, were of fundamental importance, and their influence on design was revolutionary. Hopkinson himself was the first to apply them in practice. Taking as the basis of his operations the form of machine designed by Edison, he modified it in accordance with the theory he had demonstrated, and the Edison-Hopkinson dynamo, with its improved armature and greatly shortened magnetic circuit, was speedily accepted not only as a machine of extraordinary merit, but as the embodiment of principles guiding all dynamo design.

Hopkinson was now in the full swing of his work as an electrical engineer, inventor, and expert. Among other inventions which appear in his numerous patents are the closed circuit transformer, the three wire system of electric distribution, and the series-parallel system of motor working in electrical railways and tramways. His inventions bear striking evidence of his scientific prescience; in several instances they were made too soon to bring him much or any return. His professional success however was great. At an unusually

early age he attained an almost unique position as an engineering consultant, mainly but by no means wholly in electrical matters. His frequent appearances in the law courts as expert witness represented only one side of a busy and varied professional life. In recent years his engineering work has concerned itself much with electric traction as well as with the carrying out of large schemes of electric lighting. He was engineer of the Manchester electric supply, and of electrical tramways at Leeds and Liverpool. He took part, as a member of Council, in the management of the three great engineering societies —the Institutions of Civil, Mechanical, and Electrical Engineers. The Electrical Engineers twice made him their President (in 1890 and 1896). His presidential address in 1890 was devoted to a review of results of magnetic research, remarkable, as indeed all his papers were, for its lucid brevity and comprehensiveness. In his address in 1896 he proposed the formation of a volunteer corps of electrical engineers. The corps was formed and he was himself its first Commanding Officer.

Throughout this active professional life, Hopkinson made time for a remarkable amount of purely scientific work, much of which was of first-rate importance. His published papers began to appear as early as 1871. They number in all about sixty-five. Ten of them are to be found in the 'Philosophical Transactions,' and many more in the 'Proceedings' of the Society.* About half of the whole number deal with magnetism, and with the applications of electricity and magnetism in engineering. It was in this field that Hopkinson accomplished the part of his work that is most widely known. Before these subjects engaged his attention, however, he had broken other ground which he continued to cultivate at intervals for many years. His earliest papers refer to miscellaneous problems in elasticity—to the rupture of an iron wire by a blow, and to the stresses produced in a disc by rapid rotation. His connection with Chance's works led him to investigate the refractive indices of glass, and this led on—through the connection afforded by Maxwell's theory of light—to a prolonged research dealing with electrostatic capacity and the phenomena of residual charge. Two papers on the residual charge of a Leyden jar were published in the 'Transactions' in 1876 and 1877 and were followed by others on the electrostatic capacity of glass and liquids,† and on specific inductive capacity,‡ and by a final paper "On the Capacity and Residual Charge of Dielectrics as affected by Temperature and Time."§ It is impossible, in a few sentences, to give any adequate summary of this important

* It is satisfactory to know that a collected edition of Hopkinson's papers will be published by the Cambridge University Press.

† 'Transactions,' 1877 and 1880.

‡ 'Proceedings,' 1886 and 1887.

§ 'Transactions,' 1897.

section of Hopkinson's original work. It was shown that a dielectric which had been subjected to successive electromotive forces of opposite polarity gave a corresponding inverted succession of residual discharges, and these were treated in the manner of Boltzmann's theory of the after-effects of mechanical strain. The specific inductive capacity of many substances was measured in the earlier experiments for periods ranging from 1/2 to 1/20,000 of a second, and was compared, on Maxwell's theory, with the refractive index for long waves. It was shown that in hydrocarbon oils the results were in agreement with Maxwell's theory, but with other substances there was generally disagreement. The last paper is of particular interest as supplying a key to this discrepancy. It describes experiments on ice, and on glass at various temperatures under high as well as low frequencies of charge and discharge, the high frequency ranging from 2,500,000 down to 8,000. The capacity of ice was found to be of the order 80, when measured by charges and discharges with a frequency of 1/10 or 1/100 second, but to have a value less than 3 when the frequency was such as one-millionth of a second. This showed that the apparently excessive capacity was to be ascribed to residual charge. Further, in the case of glass, a high temperature was found to increase the apparent capacity for comparatively slow frequency of discharge, but not for high frequency. Here, again, the difference is due to residual charge. Again, the insulation of heated glass was observed to be less after 1/50,000 second electrification than after 1/10,000 second, but to be sensibly constant for longer times of electrification. The current which flows when electromotive force is applied to a condenser is ordinarily treated as consisting of three parts, the charge proper, the polarisation or residual charge, and the conduction current due to imperfect insulation. Hopkinson pointed out the arbitrary nature of this distinction and the real continuity of the phenomena. These three terms, though separated for convenience, are really parts of one continuous magnitude. In a dielectric which exhibits residual charge and deviates from Maxwell's law, the action is essentially the same in kind as that which is found in an ordinary electrolyte.

Before noticing the large section of Hopkinson's work which relates to magnetism, mention should be made in passing of a short but suggestive paper on the Hall effect (1880), where it is suggested that the effect is completely expressed by Maxwell's "Rotatory Coefficient" of resistance, and of another "On the Seat of Electromotive Force in the Voltaic Cell" (1885), where it is pointed out that the controversy between those who held the difference of potential between metals in contact to have the value deduced from electrostatic experiments, and those who held it to be measured by the Peltier effect was one of definition and of hypotheses used for the expression of admitted facts.

A paper "On the Theory of Alternating Currents" (1884) discusses the action of one alternate current machine on another when the two are connected in parallel or in series. It shows that the machines will not work together in series, for they control each other's phase so as to nullify each other's effects; but that they will work together in parallel, the mutual control being then such as to produce synchronism. This conclusion was verified by experiments on a pair of alternate current dynamos intended for use at the lighthouse of Tino. Incidentally the same paper touches on the theory of induction coils, a subject which Hopkinson developed in a later paper.* There, in remarkably brief compass, a complete theory is stated of the action of the closed-circuit transformer. Later still, Hopkinson returned to the discussion of the alternate-current dynamo, and described in a paper written jointly with Mr. E. Wilson,† a series of experiments undertaken to examine the currents induced in the coils and cores of the field magnets by the movement and variation of currents in the armature.

His earliest important paper dealing with the magnetic quality of metals was published in 1885,‡ under the title "Magnetisation of Iron," and it is characteristic of the modesty of the man that in the preamble, after speaking of the work of other experimenters in the same field, he says, "I have had great doubts whether it was desirable that I should publish my own experiments at all." In point of fact, the paper is conspicuously valuable. It contains many useful data relating to samples of steel of known and very various composition, as to magnetic permeability, magnetic hysteresis, and electric resistance. One of the samples tested was the curious alloy or mixture of steel and manganese invented by Mr. Hadfield, which is almost wholly destitute of magnetic quality. The magnetic measurements were made by a novel method, each sample being a short bar, which was brought approximately to the condition of endlessness, in the magnetic sense, by being enclosed within a massive yoke of soft iron. Apart from its originality in respect of both experimental method and results the paper contains much suggestive comment on points of theory connected with the experiments. It came to be regarded, quickly and rightly, as a landmark in the development of the subject.

An examination of the magnetic properties of nickel at various temperatures followed.§ This showed that in the specimen of not very pure nickel tested the magnetic quality was lost when the temperature rose to about 310° C. But the loss was somewhat gradual over a range of some 50°, and observations of the rate of cooling from a high temperature showed no sudden liberation of heat, such

* 'Roy. Soc. Proc.,' 1887.
† 'Phil. Trans.,' A, 1895.
‡ 'Phil. Trans.'
§ 'Roy. Soc. Proc.,' 1888.

as occurs in iron as it passes from the non-magnetisable to the magnetisable state.

The behaviour of iron near this critical state was the subject of Hopkinson's next magnetic paper.* It was shown that for small magnetising forces the permeability of iron increases very rapidly as the critical temperature is approached, and then very suddenly disappears, also that the critical temperature is marked by a sudden change in the coefficient of resistance, and that it is the point at which recalescence occurs. The evolution of heat in recalescence was measured.

The same methods of inquiry were applied in the following year to certain alloys of nickel and iron, which were found to be capable of existing, throughout a wide range of temperature, in two states, one magnetisable and the other not. The state changed from non-magnetisable to magnetisable when the alloy was cooled somewhat below 0° C., but did not change back again until it was heated to nearly 600° C. In the non-magnetisable state the nickel steel was soft and ductile; in the other state it was hard. Equally marked differences were found in respect of electrical resistance. A later series of experiments deal with time-lag in the process of magnetisation, especially on the influence which the electric currents induced in the iron by magnetisation have in retarding the acquirement of magnetism.† The growth of magnetism was observed in a very massive iron core, by means of exploring coils buried at various places in its substance, and the results were applied to determine the appropriate thickness of laminated iron in transformers subjected to periodic reversals of magnetism. These experiments formed the subject of a Friday evening discourse at the Royal Institution, which concluded with a remarkable speculation as to the possibility of terrestrial magnetism being due to currents in the material of the earth sustained by its changing induction but gradually dying away.

In these and others of his later researches Hopkinson worked in co-operation with Mr. E. Wilson, his assistant at King's College, and the results were published in their joint names. The authorities of King's had invited Hopkinson, in 1890, to assume the direction of the Siemens Laboratory at King's with the title of Professor of Electrical Engineering. The post made no considerable demand on him as a teacher, but it gave him the use of a laboratory and the opportunity of suggesting to students subjects of research. He was, moreover, able to place a number of the King's College students in engineering situations, and the uniform success of the young men he favoured in this way showed that he exercised his patronage with rare judgment,

* 'Phil. Trans.,' A, 1889.

† 'Phil. Trans.,' A, 1894; 'Inst. Elect. Eng.,' 1895.

and that the students had themselves benefited greatly in coming under his influence.

Important as his various contributions to the experimental side of magnetism are, Hopkinson rendered an even greater service to the subject by his definite formulation of the theory of the magnetic circuit. This was contained in the paper on dynamo-electric machinery written in conjunction with his brother Edward,* to which allusion has already been made. The conception that the whole line-integral of the magnetic force is divisible into a series of terms for the substances of various permeability of which the circuit may be composed was as fruitful as it was simple. It threw a flood of light on phenomena which before that had received only empirical treatment. The notion of the magnetic circuit had been vaguely present to the minds of several earlier writers. Hopkinson's expression of it made it for the first time clear and convincing, and the use to which it was put in the same paper demonstrated its value on the practical side, by showing its applicability to dynamo design.

Dr. Hopkinson was elected a Fellow of the Society in 1878. He served twice on the Council, and in 1890 a Royal Medal was awarded to him for his researches in magnetism and electricity. Speaking on that occasion at the anniversary banquet, in reply to the toast of "The Medallists," he described himself as a professional man desiring to further the pure science of his subject on lines suggested by his professional work. He owed, he said, to his father his first taste for science, and to Sir William Thomson his first impulse towards research.

He married in 1873 Evelyn, daughter of Gustave Oldenburg, who survives him with three children. Three others, two daughters and a son, were killed with their father in the accident which brought Dr. Hopkinson's brilliant career to an untimely end.

A devoted lover of the mountains and an accomplished climber, he generally spent the autumn in the Alps with his family, who shared his taste and, in great measure, his skill. They spent August last at Arolla, and were much on the mountains. On the morning of August 27, Dr. Hopkinson set out, with his son Jack and his daughters Alice and Lina, to climb the Petite Dent de Veisivi, a rocky ridge above Evolena, offering no particular difficulty to a party of their experience. When they failed to return at nightfall search parties were organised, and at daybreak, on the 28th, the four bodies were found under the cliffs, roped together, having fallen from a height of some 500 feet. The cause of the accident is not known; but it is probable that the son, who was leading, slipped in consequence of a portion of the rock giving way, or that he was swept down by a falling stone. It has been well described as the saddest Alpine accident ever known.

* 'Phil. Trans.,' 1886.

The distinction and value of John Hopkinson's scientific work are so evident and so universally acknowledged, that no attempt at appraisement is required. His writings are terse enough to make careful reading imperative, but there is no trace of ambiguity or vagueness. They give an impression of easy mastery that is rare, even in work of the first class. His attack on any subject is conspicuous for its directness and severe simplicity. Any preconceived ideas which might impede it are brushed aside; nothing is taken for granted, nothing is slurred over. This indeed was a reflection of the nature of the man. Straightforwardness, simplicity, intellectual honesty were of his very essence. Admiration for his genius was not more universal than respect for his peculiarly fine character, which, moreover, compelled the warm affection of those who knew him best.

J. A. E.